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(21) International Application Number: PCT/EP96/02764 (22) International Filing Date: 20 June 1996 (20.06.96) (30) Priority Data: 9513261.9 29 June 1995 (29.06.95) GB (71) Applicant (for all designated States except US): SMITHKLINE BEECHAM BIOLOGICALS S.A. [BE/BE]; Rue de l'Institut 89, B-1330 Rixensart (BE). (72) Inventors; and (75) Inventors/Applicants (for US only): CABEZON SILVA, Teresa [CL/BE]; SmithKline Beecham Biological S.A., Rue de l'Institut 89, B-1330 Rixensart (BE). MOMIN, Patricia, Marie [BE/BE]; SmithKline Beecham Biologicals S.A., Rue de l'Institut 89, B-1330 Rixensart (BE). GARÇON, Nathalie, Marie-Josephe, Claude [FR/BE]; SmithKline Beecham Biologicals S.A., Rue de l'Institut 89, B-1330 Rixensart (BE). (74) Agent: WEST, Vivien; SmithKline Beecham, Corporate Intellectual Property, SB House, Great West Road, Brentford, Middlesex TW8 9BD (GB).		(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published <i>Without international search report and to be republished upon receipt of that report.</i>	
(54) Title: VACCINES AGAINST HEPATITIS C			
(57) Abstract			
<p>A vaccine composition comprises QS21,3 De-O-acylated monophosphoryl lipid A (3D-MPL), an oil in water emulsion, wherein the oil in water emulsion has the following composition: a metabolisable oil, such as squalene, alpha tocopherol and tween 80, and at least one immunogen selected from the group consisting of (a) a hepatitis C virus core protein or an immunogenic derivative thereof, and (b) a hepatitis C virus envelope protein or an immunogenic derivative thereof.</p>			

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VACCINES AGAINST HEPATITIS C

The present invention relates to novel vaccine formulations, to methods of their production and to their use in medicine.

5 3 De-O-acylated monophosphoryl lipid A is known from GB2 220 211 (Ribi). Chemically it is a mixture of 3 De-O-acylated monophosphoryl lipid A with 4, 5 or 6 acylated chains and is manufactured by Ribi Immunochem Montana. A preferred form of 3 De-O-acylated monophosphoryl lipid A is disclosed in International Patent Application No. 92/116556.

10 QS21 is a Hplc purified non toxic fraction of a saponin from the bark of the South American tree Quillaja Saponaria Molina and its method of its production is disclosed (as QA21) in US patent No. 5,057,540.

Oil in water emulsions per se are known in the art, and have been suggested to be useful as adjuvant compositions (EPO 399843).

15 Hepatitis C virus is described in EP-A-0 318 216. A particular antigenic protein of hepatitis C virus has been designated the core protein and is described by, for example, Delisse et al., J. Hepatology, 1991;13 (Suppl. 4): S20-S23 (for genotype 1b). Particular envelope proteins of hepatitis C virus have been designated E1 and E2 and are described by, for example, Grakoui et al., 1993, J. Virology 67, 1385-1395; Spacte et al., 1992, Virology 188, 819-830; Matsumia et al., J. Virology 66, 1425-1431, and Kohara et al., 1992, J. Gen. Virol. 73, 2313-2318. A majority of the HCV genotypes identified to date are described by Okamoto Hiroaki and Mishiro Shunji, Intervirology, 1994, 37: 68 et seq.

25 The present invention provides a vaccine composition comprising QS21, 3 De-O-acylated monophosphoryl lipid A (3D-MPL), an oil in water emulsion, wherein the oil in water emulsion has the following composition: a metabolisable oil, such as squalene, alpha tocopherol and tween 80, and at least one immunogen selected from the group consisting of (a) a hepatitis C virus core protein or an immunogenic derivative thereof, and (b) a hepatitis C virus envelope protein or an immunogenic derivative thereof.

30 The term "immunogenic derivative" encompasses any molecule such as a truncated or other derivative of the protein which retains the ability to induce an immune response to the protein following internal administration to a human. Such other derivatives can be prepared by the addition, deletion, substitution, or rearrangement of amino acids or by chemical modifications thereof.

Immunogenic fragments of the protein, which may be useful in the preparation of subunit vaccines, may be prepared by expression of the

appropriate gene fragments or by peptide synthesis, for example using the Merrifield synthesis (The Peptides, Vol 2., Academic Press, NY, page 3).

The immunogenic derivative of the invention can be a hybrid, that is, a fusion polypeptide containing additional sequences which can carry one or more epitopes for other immunogens. Alternatively, the immunogenic derivative of the invention can be fused to a carrier polypeptide or to another carrier which has immunostimulating properties, as in the case of an adjuvant, or which otherwise enhances the immune response to the protein or derivative thereof, or which is useful in expressing, purifying or formulating the protein or derivative thereof.

The invention also extends to the HCV protein or immunogenic derivative thereof when chemically conjugated to a macromolecule using a conventional linking agent such as glutaraldehyde (Geerlings et al, (1988) J. Immunol. Methods, 106, 239-244).

Proteins and their immunogenic derivatives suitable for use in the present invention can be prepared by expressing DNA encoding said protein or derivative thereof in a recombinant host cell and recovering the product, and thereafter, optionally, preparing a derivative thereof.

A DNA molecule comprising such coding sequence can be synthesized by standard DNA synthesis techniques, such as by enzymatic ligation as described by D.M. Roberts *et al* in Biochemistry 1985, 24, 5090-5098, by chemical synthesis, by *in vitro* enzymatic polymerization, or by a combination of these techniques.

Enzymatic polymerisation of DNA may be carried out *in vitro* using a DNA polymerase such as DNA polymerase I (Klenow fragment) in an appropriate buffer containing the nucleoside triphosphates dATP, dCTP, dGTP and dTTP as required at a temperature of 10⁰-37⁰C, generally in a volume of 50ml or less. Enzymatic ligation of DNA fragments may be carried out using a DNA ligase such as T4 DNA ligase in an appropriate buffer, such as 0.05M Tris (pH 7.4), 0.01M MgCl₂, 0.01M dithiothreitol, 1mM spermidine, 1mM ATP and 0.1mg/ml bovine serum albumin, at a temperature of 4⁰C to ambient, generally in a volume of 50ml or less. The chemical synthesis of the DNA polymer or fragments may be carried out by conventional phosphotriester, phosphite or phosphoramidite chemistry, using solid phase techniques such as those described in 'Chemical and Enzymatic Synthesis of Gene Fragments - A Laboratory Manual' (ed. H.G. Gassen and

A. Lang), Verlag Chemie, Weinheim (1982), or in other scientific publications, for example M.J. Gait, H.W.D. Matthes, M. Singh, B.S. Sproat, and R.C. Titmas, *Nucleic Acids Research*, 1982, 10, 6243; B.S. Sproat and W. Bannwarth, *Tetrahedron Letters*, 1983, 24, 5771; M.D. Matteucci and
5 M.H. Caruthers, *Tetrahedron Letters*, 1980, 21, 719; M.D. Matteucci and M.H. Caruthers, *Journal of the American Chemical Society*, 1981, 103, 3185; S.P. Adams et al., *Journal of the American Chemical Society*, 1983, 105, 661; N.D. Sinha, J. Biernat, J. McMannus, and H. Koester, *Nucleic Acids Research*, 1984, 12, 4539; and H.W.D. Matthes et al., *EMBO Journal*, 1984,
10 3, 801.

DNA polymers which encode mutants may be prepared by site-directed mutagenesis by conventional methods such as those described by G. Winter *et al* in *Nature* 1982, 299, 756-758 or by Zoller and Smith 1982; *Nucl. Acids Res.*, 10, 6487-6500, or deletion mutagenesis such as
15 described by Chan and Smith in *Nucl. Acids Res.*, 1984, 12, 2407-2419 or by G. Winter *et al* in *Biochem. Soc. Trans.*, 1984, 12, 224-225.

Recombinant techniques are described in Maniatis *et. al.*, *Molecular Cloning - A Laboratory Manual*; Cold Spring Harbor, 1982-1989.

In particular, a protein or immunogenic derivative for use in the
20 present invention can be prepared using the following steps:

- i) preparing a replicable or integrating expression vector capable, in a host cell, of expressing a DNA polymer comprising a nucleotide sequence that encodes said protein or an immunogenic derivative thereof;
- 25 i) transforming a host cell with said vector;
- iii) culturing said transformed host cell under conditions permitting expression of said DNA polymer to produce said protein; and
- 30 iv) recovering said protein.

The term 'transforming' is used herein to mean the introduction of foreign DNA into a host cell by transformation, transfection or infection with
35 an appropriate plasmid or viral vector using e.g. conventional techniques as described in *Genetic Engineering*; Eds. S.M. Kingsman and A.J. Kingsman;

Blackwell Scientific Publications; Oxford, England, 1988. The term 'transformed' or 'transformant' will hereafter apply to the resulting host cell containing and expressing the foreign gene of interest.

5 The replicable expression vector may be prepared by cleaving a vector compatible with the host cell to provide a linear DNA segment having an intact replicon, and combining said linear segment with one or more DNA molecules which, together with said linear segment encode the desired product, under ligating conditions.

10 Thus, the DNA polymer may be preformed or formed during the construction of the vector, as desired.

The choice of vector will be determined in part by the host cell, which may be prokaryotic or eukaryotic. Suitable vectors include plasmids, bacteriophages, cosmids and recombinant viruses.

15 The preparation of the replicable expression vector may be carried out conventionally with appropriate enzymes for restriction, polymerisation and ligation of the DNA, by procedures described in, for example, Maniatis *et al* cited above.

20 The recombinant host cell is prepared by transforming a host cell with a replicable expression vector under transforming conditions. Suitable transforming conditions are conventional and are described in, for example, Maniatis *et al* cited above, or "DNA Cloning" Vol. II, D.M. Glover ed., IRL Press Ltd, 1985.

25 The choice of transforming conditions is determined by the host cell. Thus, a bacterial host such as *E. coli* may be treated with a solution of CaCl_2 (Cohen *et al*, Proc. Nat. Acad. Sci., 1973, 69, 2110) or with a solution comprising a mixture of RbCl , MnCl_2 , potassium acetate and glycerol, and then with 3-[N-morpholino]-propane-sulphonic acid, RbCl and glycerol. Mammalian cells in culture may be transformed by calcium co-precipitation of the vector DNA onto the cells.

30 Culturing the transformed host cell under conditions permitting expression of the DNA polymer is carried out conventionally, as described in, for example, Maniatis *et al* and "DNA Cloning" cited above. Thus, preferably the cell is supplied with nutrient and cultured at a temperature below 45°C .

35 The product is recovered by conventional methods according to the host cell. Thus, where the host cell is bacterial, such as *E. coli* it may be

lysed physically, chemically or enzymatically and the protein product isolated from the resulting lysate. Where the host cell is mammalian, the product may generally be isolated from the nutrient medium or from cell free extracts.

Conventional protein isolation techniques include selective precipitation, absorption chromatography, and affinity chromatography including a monoclonal antibody affinity column.

Preferably, the host cell is E. coli.

A particular aspect of the present invention provides a novel compound which comprises an HCV core protein, or an immunogenic derivative thereof, fused to a polypeptide containing foreign epitopes. The polypeptide is preferably an influenza protein, such as the NS1 protein, or an immunogenic derivative thereof. DNA coding for such a novel compound, vectors containing said DNA, host cells transformed with said vectors, and their use in producing said novel compound, form still further aspects of the invention claimed.

The vaccines of the present invention are preferential stimulators of IgG2a production and TH1 cell response. This is advantageous, because of the known implication of TH1 response in cell mediated response. Indeed in mice induction of IgG2a is correlated with such an immune response.

The vaccines of the invention enhance induction of cytolytic T lymphocyte responses. Induction of CTL is easily seen when the target antigen is synthesised intracellularly, ie during infection by the virus, because peptides generated by proteolytic breakdown of the antigen can enter the appropriate processing pathway, leading to presentation in association with class I molecules on the cell membrane. However, in general, pre-formed soluble antigen does not reach this processing and presentation pathway, and does not elicit class I restricted CTL. Therefore conventional non-living vaccines, while eliciting antibody and T helper responses, do not generally induce CTL mediated immunity. The combination of the two adjuvants QS21 and 3D-MPL together with an oil in water emulsion can overcome this serious limitation of vaccines based on recombinant proteins, and induce a wider spectrum of immune responses.

In certain systems, the combination of 3D-MPL and QS21 together with an oil in water emulsion have been able to synergistically enhance interferon γ production.

Additionally the oil in water emulsion may contain span 85 and/or lecithin. A preferred form of 3 De-O-acylated monophosphoryl lipid A is disclosed in International patent application published under No. 92116556 - SmithKline Beecham Biologicals s.a.

The oil in water emulsion may be utilised on its own or with other adjuvants or immuno-stimulants

In a further aspect of the present invention there is provided a vaccine as herein described for use in medicine.

5 The ratio of QS21 : 3D-MPL will typically be in the order of 1 : 10 to 10 : 1; preferably 1 : 5 to 5 : 1 and often substantially 1 : 1. The preferred range for optimal synergy is 2.5:1 to 1:1 3D MPL: QS21. Typically for human administration QS21 and 3D MPL will be present in a vaccine in the range 1 µg - 100 µg, preferably 10 µg - 50 µg per dose. Typically the oil in water will comprise from 2 to 10% squalene, from 2
10 to 10% alpha tocopherol and from 0.3 to 3% tween 80. Preferably the ratio of squalene: alpha tocopherol is equal or less than 1 as this provides a more stable emulsion. Span 85 may also be present at a level of 1%. In some cases it may be advantageous that the vaccines of the present invention will further contain a stabiliser.

15 Vaccine preparation is generally described in New Trends and Developments in Vaccines, edited by Voller et al., University Park Press, Baltimore, Maryland, U.S.A. 1978. Encapsulation within liposomes is described, for example, by Fullerton, U.S. Patent 4,235,877. Conjugation of proteins to macromolecules is disclosed, for example, by Likhite, U.S. Patent 4,372,945 and by Armor et al., U.S. Patent 4,474,757.

20 The amount of protein in each vaccine dose is selected as an amount which induces an immunoprotective response without significant, adverse side effects in typical vaccinees. Generally, it is expected that each dose will comprise 1-1000 µg of protein, preferably 2-100 µg. An optimal amount for a particular vaccine can be ascertained by standard studies involving observation of appropriate immune responses
25 in subjects. Following an initial vaccination, subjects may receive one or several booster immunisation adequately spaced.

The formulations of the present invention may be used for both prophylatic and therapeutic purposes.

30 Accordingly in one aspect, the invention provides a method of treatment comprising administering an effective amount of a vaccine of the present invention to a patient.

The following examples illustrate the invention.

Example 1

1.1 Construction and expression of a recombinant HCV core fusion protein

5 Plasmid pMG81 a derivative of pMG27 (Gross et al 1985, Mol.Cell. Biol. 5: 1015) in which: (i) the 81 first codons of the NS1 coding region from influenza strain A/PR/8/34 cleaved from plasmid pAS1EH/801 (Young et al. 1983, Proc. Natl. Acad. Sci. 80: 6105) have been inserted downstream of the pL promoter and ii) the ampicillin resistance gene has been replaced by the kanamycin resistance gene from transposon
10 Tn902, was used to express the fusion protein NS1-Core.

HCV genomic sequences of hepatitis C virus genotype 1b (Delisse et al, 1991 J. Hepathology 13, suppl. 4:S20-23) were PCR amplified and cloned into pUC12 plasmid to give plasmid TCM128-2.

15 The nucleotides sequences corresponding to amino acids 2-166 of the core protein were amplified from TCM128-2. During the polymerase chain reaction, NcoI and XbaI restriction sites have been generated at the 5' and 3' ends of the core sequences allowing insertion into the same sites of plasmid pMG81 to give pRIT 14129.

20 pRIT 14129 contains the coding sequence for the fusion protein NS1 (flu)-core(HCV) and expresses the polypeptide described in SEQ ID NO. 1. The coding sequence for the fusion protein NS1 (flu)-core(HCV) is contained in SEQ ID NO 2. SEQ ID NO 3 shows the amino acid sequence 1-1006 of HCV genome type 1a (H).

25 Plasmid pRIT14129 was introduced into E. coli AR 58 (Mott et al, 1985, Proc, Natl. Acad. Sci., 82:88) containing the thermosensitive repressor of the λ pL promoter.

30 The recombinant bacteria were grown in a 20 Liters fermentor under fed-batch conditions at 30°. The expression of the NS1-Core protein was induced by raising the temperature to 38-42°C. The cells were then harvested and mechanically disrupted.

1.2 Purification of the NS1-Core fusion protein

35 The antigen was purified in a denatured form by preparative electrophoreses:

35 Tween 80 is dissolved in phosphate buffered saline (PBS) to give a 2% solution in the PBS. To provide 100 ml two fold concentrate emulsion 5g of DL alpha tocopherol and 5ml of squalene are vortexed to mix thoroughly. 90ml of PBS/Tween solution is added and mixed thoroughly. The resulting emulsion is then passed through a syringe

and finally microfluidised by using an M110S microfluidics machine. The resulting oil droplets have a size of approximately 180 nm.

1(b) Preparation of emulsion SB26

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This emulsion was prepared in an analogous manner utilising 0.4% tween 80.

1(c) Other emulsions as depicted in the Table were made in an analogous manner.

10 1(d) Preparation of fusion protein/QS21/3D MPL/ oil in water formulation.

To the emulsion of 1 a) or b) or c) an equal volume of twice concentrated fusion protein(either 20µg or 100µg) was added and mixed. This was combined with 50µg/ml of 3D-MPL and 20µg/ml of QS21 to give the final formulation. Buffer was
15 set according to salt content and pH.

Example 2

2.1 Preparation of a recombinant E1E2 oligomeric protein

20

Oligomeric forms of E1-E2 HCV envelope proteins can be prepared form mammalian cells infected with recombinant vaccinia virus expressing HCV envelope sequences as a polyprotein. The coding sequences for a polyprotein covering the amino acids 167-1006 of HCV genome of type 1a (H) can be inserted in vaccinia virus vectors using
25 procedures known in the art and the resulting plasmid used to prepared vaccinia recombinant virus that will lead to expression of the polyprotein in infected cells. The expressed polyprotein is processed and retained intracellularly. E1-E2 oligomeric form can be purified from cell extracts in which the E1/E2 protein complex has been solubilized using specific detergent (Ralston et al, 1993, J. Virology 67:6753)
30 (Dubuisson et al 1994, J. Virology 68:6147).

2.2 Preparation of vaccine formulations

Formulations of oligomeric E1E2 are prepared analagously to the formulations of
35 Example 1.

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Example 3

- Formulations containing both the fusion protein of Example 1 and the E1E2 oligomer
- 5 of Example 2 are prepared analagously to the formulations of Example 1, each formulation containing between 50 and 100µg of each protein.

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Table 1Vehicles two fold concentrated

5

Emulsions SB	Tocopherol %	Squalene %	Tween 80 %	Span 85 %	Lecithin %	Size
26	5	5	0.4	0	0	500 nm 90-100% 800 nm 10-0%
26.1	5	5	0.4	0	0.1	500 nm
63	5	5	0.6	0	0	500 nm
64	5	5	0.8	0	0	500 nm
61	5	5	1	0	0	250-300 nm
62	5	5	2	0	0	180 nm
40	5	5	0.4	1	0	500 nm 80-100% 800 nm 20-0%
40.1	5	5	0.4	1	0.1	500 nm
60	5	5	1	1	0	300 nm
65	5	5	0.4	1.5	0	500 nm
66	5	5	0.4	2	0	500 nm

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SEQ ID NO 1

1 MDPNTVSSFQ VDCFLWHVRK RVADQELGDA PFLDRLRRDQ KSLRGRGSTL
 5 51 GLDIETATRA GKQIVERILK EESDEALKMT MSTNPKPQRK TKRNTNRRPQ
 101 DVKFPGGGQI VGGVYLLPRR GPRLGVRATR KTSERSQPRG RRQPIPKARQ
 151 PEGRAWAQPG YPWPLYGNEG MGWAGWLLSP RGSRPSWGPT DPRRRSRNLG
 10 201 KVIDTLTCGF ADLMGYIPLV GAPPGGAARA LAHGVRVLED GVNyat

SEQ ID NO 2

15 1 GAATTTCGTAC CTAGATCTCT CACCTACCAA ACAATGCCCC CCTGCAAAAA
 51 ATAAATTCAT ATAAAAACA TACAGATAAC CATCTGCGGT GATAAATTAT
 101 CTCTGGCGGT GTTGACATAA ATACCACTGG CGGTGATACT GAGCACATCA
 20 151 GCAGGACGCA CTGACCACCA TGAAGGTGAC GCTCTTAAAA ATTAAGCCCT
 201 GAAGAAGGGC AGCATTCAAA GCAGAAGGCT TTGGGGTGTG TGATACGAAA
 25 251 CGAAGCATTG GCCGTAAGTG CGATTCCGGA TTAGCTGCCA ATGTGCCAAT
 301 CGCGGGGGGT TTTCGTTTCTAG GACTACAACCT GCCACACACC ACCAAAGCTA
 351 ACTGACAGGA GAATCCAGAT GGATGCACAA ACACGCCGCC GCGAACGTCG
 30 401 CGCAGAGAAA CAGGCTCAAT GGAAAGCAGC AAATCCCCTG TTGGTTGGGG
 451 TAAGCGCAA ACCAGTTCCG AAAGATTTTT TTAACATAA ACGCTGATGG
 35 501 AAGCGTTTAT GCGGAAGAGG TAAAGCCCTT CCCGAGTAAC AAAAAACAA
 551 CAGCATAAAT AACCCCGCTC TTACACATTC CAGCCCTGAA AAAGGGCATC
 601 AAATTAAACC ACACCTTAAG GAGGATATAA CATATGGATC CAAACACTGT
 40 651 GTCAAGCTTT CAGGTAGATT GCTTTCTTTG GCATGTCCGC AAACGAGTTG
 701 CAGACCAAGA ACTAGGTGAT GCGCCATTCC TTGATCGGCT TCGCCGAGAT
 45 751 CAGAAATCCC TAAGAGGAAG GGGCAGCACT CTTGGTCTGG ACATCGAGAC
 801 AGCCACACGT GCTGGAAAGC AGATAGTGGA GCGGATTCTG AAAGAAGAAT
 851 CCGATGAGGC ACTTAAAATG AcCATGAGCA CAAATCCTAA ACCCCAAAGA
 50 901 AAAACCAAAC GTAACACCAA CCGTCGCCCA CAGGACGTTA AGTTCCCGGG
 951 CGGTGGTCAG ATCGTtGGTG GAGTTTACcT GTTGCCGCGC AGGGGCCCCA
 55 1001 GGTtGGGTGT GCGcGCGACT AGGAAGACTT CCGAGCGGTc GCAACCTCGT
 1051 GGAAGGCGAC AgCCTATCCC CAAGGCTCGC CaGCCCAGAG GtAGGgCCTG
 1101 GGCaCAGCCc GGGTATCCTT GGCCCTCTA TGGCAATGAG GGCaTGGGGT
 60 1151 GGGCAGGATG GCTCCTGTCA CCGCGCGGCT CcCGGCCTAG TTGGGGCCCC
 1201 AcgGACCCCC GCGTAGGTC GCGTAATTTG GGTAAGGTCA TCGATACCCT
 65 1251 cACgTGCGGC TTCGCCGACC TCATGGGGTA CATTCCGCTC GTCGGCGCCC
 1301 CCccAGGGGG CGCTGCCAGG GCctTGGCAC ATGGTGTCCG GGTtCTGGAG

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1351 GACGGCGTGA ACTATGCAAC AtaaTCTAGA ATCGATAAGC TTCGACCGAT
 5 1401 GCCCTTGAGA GCCTTCAACC CAGTCAGCTC CTTCCGGTGG GCGCGGGGCA
 1451 TGACTATCGT CGCCGCACTT ATGACTGTCT TCTTTATCAT GCAACTCGTA
 1501 GGACAGGTGC CGGCAGCGCT CTGGGTCATT TTCGGCGAGG ACCGCTTTTCG
 10 1551 CTGGAGCGCG ACGATGATCG GCCTGTCGCT TGCGGTATTC GGAATCTTGC
 1601 ACGCCCTCGC TCAAGCCTTC GTCACTGGTC CCGCCACCAA ACGTTTTCGGC
 1651 GAGAAGCAGG CCATTATCGC CGGCATGGCG GCCGACGCGC TGGGCTACGT
 15 1701 CTTGCTGGCG TTCGTCCAGT AATGACCTCA GAACTCCATC TGGATTTGTT
 1751 CAGAACGCTC GGTGCGCGCC GGGCGTTTTT TATTGGTGAG AATCGCAGCA
 20 1801 ACTTGTCGCG CCAATCGAGC CATGTCGTCTG TCAACGACCC CCCATTCAAG
 1851 AACAGCAAGC AGCATTGAGA ACTTTGGAAT CCAGTCCCTC TTCCACCTGC
 1901 TGACGACGCG AGGCTGGATG GCCTTCCCCA TTATGATTCT TCTCGCTTCC
 25 1951 GCGGGCATCG GGATGCCCCG GTTGCAGGCC ATGCTGTCCA GGCAGGTAGA
 2001 TGACGACCAT CAGGGACAGC TTCAAGGATC GCTCGCGGCT CTTACCAGCC
 30 2051 TAACTTCGAT CACTGGACCG CTGATCGTCA CGGCGATTTA TGCCGCCTCG
 2101 GCGAGCACAT GGAACGGGTT GGCATGGATT GTAGGCGCCG CCCTATACCT
 2151 TGTCTGCCTC CCCGCGTTGC GTCGCGGTGC ATGGAGCCGG GCCACCTCGA
 35 2201 CCTGAATGGA AGCCGGCGGC ACCTCGCTAA CGGATTACAC ACTCCAAGAA
 2251 TTGGAGCCAA TCAATTCTTG CGGAGAACTG TGAATGCGCA AACCAACCCT
 40 2301 TGGCAGAACA TATCCATCGC GTCCGCCATC TCCAGCAGCC GCACGCGGCG
 2351 CATCTCGGGC AGCGTTGGGT CCTGGCCACG GGTGCGCATG ATCGTGCTCC
 2401 TGTCGTTGAG GACCCGGCTA GGCTGGCGGG GTTGCCTTAC TGTTAGCAG
 45 2451 AATGAATCAC CGATACGCGA GCGAACGTGA AGCGACTGCT GCTGCAAAAC
 2501 GTCTGCGACC TGAGCAACAA CATGAATGGT CTTCCGTTTC CGTGTTTCGT
 50 2551 AAAGTCTGGA AACGCGGAAG TCAGCGCCCT GCACCATTAT GTTCCGGATC
 2601 TGCATCGCAG GATGCTGCTG GCTACCCTGT GGAACACCTA CATCTGTATT
 2651 AACGAAGCGC TGGCATTGAC CCTGAGTGAT TTTTCTCTGG TCCCGCCGCA
 55 2701 TCCATACCGC CAGTTGTTTA CCCTCACAAC GTTCCAGTAA CCGGCATGT
 2751 TCATCATCAG TAACCCGTAT CGTGAGCATC CTCTCTCGTT TCATCGGTAT
 60 2801 CATTACCCCC ATGAACAGAA ATTCCCCCTT ACACGGAGGC ATCAAGTGAC
 2851 CAAACAGGAA AAAACCGCCC TTAACATGGC CCGCTTTATC AGAAGCCAGA
 2901 CATTAACGCT TCTGGAGAAA CTCAACGAGC TGGACGCGGA TGAACAGGCA
 65 2951 GACATCTGTG AATCGCTTCA CGACCACGCT GATGAGCTTT ACCGCAGCTG
 3001 CCTCGCGCGT TTCGGTGATG ACGGTGAAAA CCTCTGACAC ATGCAGCTCC

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	3051	CGGAGACGGT	CACAGCTTGT	CTGTAAGCGG	ATGCCGGGAG	CAGACAAGCC
5	3101	CGTCAGGGCG	CGTCAGCGGG	TGTTGGCGGG	TGTCGGGGCG	CAGCCATGAC
	3151	CCAGTCACGT	AGCGATAGCG	GAGTGTATAC	TGGCTTAACT	ATGCGGCATC
	3201	AGAGCAGATT	GTACTGAGAG	TGCACCATAT	ATGCGGTGTG	AAATACCGCA
10	3251	CAGATGCGTA	AGGAGAAAAT	ACCGCATCAG	GCGCTCTTCC	GCTTCCTCGC
	3301	TCACTGACTC	GCTGCGCTCG	GTGCTTCGGC	TGCGGCGAGC	GGTATCAGCT
15	3351	CACTCAAAGG	CGGTAATACG	GTTATCCACA	GAATCAGGGG	ATAACGCAGG
	3401	AAAGAACATG	TGAGCAAAAG	GCCAGCAAAA	GGCCAGGAAC	CGTAAAAAGG
	3451	CCGCGTTGCT	GGCGTTTTTC	CATAGGCTCC	GGCCCCCTGA	CGAGCATCAC
20	3501	AAAAATCGAC	GCTCAAGTCA	GAGGTGGCGA	AACCCGACAG	GACTATAAAAG
	3551	ATACCAGGCG	TTTCCCCCTG	GAAGCTCCCT	CGTGCGCTCT	CCTGTTCCGA
25	3601	CCCTGCCGCT	TACCGGATAC	CTGTCCGCCT	TTCTCCCTTC	GGGAAGCGTG
	3651	GCGCTTTCTC	AATGCTCACG	CTGTAGGTAT	CTCAGTTCGG	TGTAGGTCGT
	3701	TCGCTCCAAG	CTGGGCTGTG	TGCACGAACC	CCCCGTTTCA	CCCGACCGCT
30	3751	GCGCCTTATC	CGGTAACAT	CGTCTTGAGT	CCAACCCGGT	AAGACACGAC
	3801	TTATCGCCAC	TGGCAGCAGC	CACTGGTAAC	AGGATTAGCA	GAGCGAGGTA
35	3851	TGTAGGCGGT	GCTACAGAGT	TCTTGAAGTG	GTGGCCTAAC	TACGGCTACA
	3901	CTAGAAGGAC	AGTATTTGGT	ATCTGCGCTC	TGCTGAAGCC	AGTTACCTTC
	3951	GGAAAAAGAG	TTGGTAGCTC	TTGATCCGGC	AAACAAACCA	CCGCTGGTAG
40	4001	CGGTGGTTTT	TTTGTTTGCA	AGCAGCAGAT	TACGCGCAGA	AAAAAAGGAT
	4051	CTCAAGAAGA	TCCTTTGATC	TTTTCTACGG	GGTCTGACGC	TCAGTGAAC
45	4101	GAAAACTCAC	GTTAAGGGAT	TTTGGTCATG	AGATTATCAA	AAAGGATCTT
	4151	CACCTAGATC	CTTTTAAATT	AAAAATGAAG	TTTTAAATCA	ATCTAAAGTA
	4201	TATATGAGTA	AACTTGGTCT	GACAGTTACC	AATGCTTAAT	CAGTGAGGCA
50	4251	CCTATCTCAG	CGATCTGTCT	ATTCGTTTCA	TCCATAGTTG	CCTGACTCCC
	4301	CGTCGTGTAG	ATAACTACGA	TACGGGAGGG	CTTACCATCT	GGCCCCAGTG
55	4351	CTGCAATGAT	ACCGCGAGAC	CCACGCTCAC	CGGCTCCAGA	TTTATCAGCA
	4401	ATAAACCAGC	CAGCCGGAAG	GGCCGAGCGC	AGAAGTGGTC	CTGCAACTTT
	4451	ATCCGCCTCC	ATCCAGTCTA	TTAATTGTTG	CCGGAAGCT	AGAGTAAGTA
60	4501	GTTCCGCCAGT	TAATAGTTTG	CGCAACGTTG	TTGCCATTGC	TGCAGGTCGA
	4551	CGGATCAGCC	TCGAGGTGAG	GTCTGCCTCG	TGAAGAAGGT	GTTGCTGACT
65	4601	CATACCAGGC	CTGAATCGCC	CCATCATCCA	GCCAGAAAGT	GAGGGAGCCA
	4651	CGGTTGATGA	GAGCTTTGTT	GTAGGTGGAC	CAGTTGGTGA	TTTTGAACCT
	4701	TTGCTTTGCC	ACGGAACGGT	CTGCGTTGTC	GGGAAGATGC	GTGATCTGAT

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4751 CCTTCAACTC AGCAAAAGTT CGATTATTTC AACAAAGCCA CGTTGTGTCT
5 4801 CAAAATCTCT GATGTTACAT TGCACAAGAT AAAAATATAT CATCATGAAC
4851 AATAAACTG TCTGCTTACA TAAACAGTAA TACAAGGGGT GTTATGAGCC
4901 ATATTCAACG GGAAACGTCT TGCTCGAGGC CGCGATTAAA TTCCAACATG
10 4951 GATGCTGATT TATATGGGTA TAAATGGGCT CGCGATAATG TCGGGCAATC
5001 AGGTGCGACA ATCTATCGAT TGTATGGGAA GCCCGATGCG CCAGAGTTGT
5051 TTCTGAAACA TGGCAAAGGT AGCGTTGCCA ATGATGTTAC AGATGAGATG
15 5101 GTCAGACTAA ACTGGCTGAC GGAATTTATG CCTCTTCCGA CCATCAAGCA
5151 TTTTATCCGT ACTCCTGATG ATGCATGGTT ACTCACCACCT GCGATCCCCG
20 5201 GGAAAACAGC ATTCCAGGTA TTAGAAGAAT ATCCTGATTG AGGTGAAAAT
5251 ATTGTTGATG CGCTGGCAGT GTTCCTGCCG CGGTTGCATT CGATTCCCTGT
5301 TTGTAATTGT CCTTTTAACA GCGATCGCGT ATTTCTGCTC GCTCAGGCGC
25 5351 AATCACGAAT GAATAACGGT TTGGTTGATG CGAGTGATTT TGATGACGAG
5401 CGTAATGGCT GGCCCTGTTGA ACAAGTCTGG AAAGAAATGC ATAAGCTTTT
30 5451 GCCATTCTCA CCGGATTCAG TCGTCACTCA TGGTGATTTC TCACTTGATA
5501 ACCTTATTTT TGACGAGGGG AAATTAATAG GTTGTATTGA TGTGGACGA
5551 GTCGGAATCG CAGACCGATA CCAGGATCTT GCCATCCTAT GGAAGTGCCT
35 5601 CGGTGAGTTT TCTCCTTCAT TACAGAAACG GCTTTTTCAA AAATATGGTA
5651 TTGATAATCC TGATATGAAT AAATTGCAGT TTCATTTGAT GCTCGATGAG
40 5701 TTTTCTAAT CAGAATTGGT TAATTGGTTG TAACACTGGC AGAGCATTAC
5751 GCTGACTTGA CGGGACGGCG GCTTTGTTGA ATAAATCGAA CTTTGTCTGA
5801 GTTGAAGGAT CAGATCACGC ATCTTCCCGA CAACGCAGAC CGTTCCGTGG
45 5851 CAAAGCAAAA GTTCAAAATC ACCAACTGGT CCACCTACAA CAAAGCTCTC
5901 ATCAACCGTG GCTCCCTCAC TTTCTGGCTG GATGATGGGG CGATTCCAGGC
50 5951 CTGGTATGAG TCAGCAACAC CTTCTTCACG AGGCAGACCT CACCTCGAGG
6001 CTGATCCCCG

SEQ ID NO 3

55 1 MSTNPKPQRK TKRNTNRRPQ DVKFPGGGQI VGVYLLPRR GPRLGVRATR
51 KTSERSQPRG RRQPIPKARR PEGRTWAQPG YPWPLYGNEG CGWAGWLLSP
60 101 RGSRPSWGPT DPRRRSRNLG KVIDTLTCGF ADLMGYIPLV GAPLGGAARA
151 LAHGVRVLED GVNYATGNLP GCSFSIFLLA LLSCLTVPAS AYQVRNSSGL
201 YHVTNDPCNS SIVYEAADAI LHTPGCVPCV REGNASRCWV AVTPTVATRD
65

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	251	GKLPTTQLRR	HIDLLVGSAT	LCSALYVGDL	CGSVFLVGQL	FTFSPPRHWT
	301	TQDCNCSIYP	GHITGHRMAW	DMMNWSPTA	ALVVAQLLRI	PQAIMDMIAG
5	351	AHWGVLAGIA	YFSMVGWNAK	VLVLLLLFAG	VDAETHVTGG	NAGRRTAGLV
	401	GLLTPGAKQN	IQLINTNGSW	HINSTALNCN	ESLNTGWLGA	LFYQHKFNSS
	451	GCPERLASCR	RLTDFAQGWG	PISYANGSGH	DERPYCWHYP	PRPCGIVPAK
10	501	SVCGPVYCFT	PSPVVVGTTD	RSGAPTYSWG	ANDTDVFLN	NTRPPLGNWF
	551	GCTWMNSTGF	TKVCGAPPCV	IGGVGNNTLL	CPTDCFRKHP	EATYSRCGSG
15	601	PWITPRCMVD	YPYRLWHYPC	TINYTIFKVR	MYVGGVEHRL	EAACNWTRGE
	651	RCDLEDRDRS	ELSPLLLSTT	QWQVLPCSFT	TLPALSTGLI	HLHQNIVDVQ
	701	YLYGVGSSIA	SWAIKWEYVY	LLFLLLADAR	VCSCLMMLL	ISQAEAALEN
20	751	LVILNAASLA	GTHGLVSFLV	FFCFAWYKLG	RWVPGAVYAL	YGMWPLLLLL
	801	LALPQRAYAL	DTEVAASCGG	VVLVGLMALT	LSPYYKRYIS	WCMWWLQYFL
25	851	TRVEAQLHWV	VPPLNVRGGR	DAVILLMCVV	HPILVFDITK	LLLAIFGPLW
	901	ILQASLLKVP	YFVRVQGLLR	ICALARKIAG	GHYVQMAIHK	LGALTGTIVY
	951	NHLTPLRDWA	HNGLRDLAVA	VEPVVFSRME	TKLITWGADT	AACGDIINGL
30	1001	PVSARR				

1. A vaccine composition comprising: QS21; 3 De-O-acylated monophosphoryl lipid A (3D-MPL); an oil in water emulsion, wherein the oil in water emulsion has the following composition: a metabolisable oil, alpha tocopherol and tween 80; and at least one immunogen selected from the group consisting of (a) a hepatitis C virus core protein or an immunogenic derivative thereof, and (b) a hepatitis C virus envelope protein or an immunogenic derivative thereof.
2. A vaccine composition according to claim 1 wherein the HCV protein or immunogenic derivative thereof is chemically conjugated to a carrier molecule.
3. A vaccine composition according to claim 1 or 2 wherein the immunogenic derivative is a fusion polypeptide.
4. A vaccine composition according to claim 3 wherein the fusion polypeptide comprises an HCV core protein or an immunogenic derivative thereof fused to an influenza protein or an immunogenic derivative thereof.
5. A vaccine composition according to claim 4 wherein the influenza protein is the NS1 protein.
6. A compound which comprises an HCV core protein, or an immunogenic derivative thereof, fused to a polypeptide containing foreign epitopes.
7. A compound according to claim 6 wherein the polypeptide containing foreign epitopes is an influenza protein or an immunogenic derivative thereof.
8. A compound according to claim 7 wherein the influenza protein is the NS1 protein.
9. A method of treating or preventing HCV infection, which comprises administering to a patient in need thereof an effective amount of a composition according to any one of claims 1 to 5 or a compound according to any one of claims 6 to 8.

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10. Use of a composition according to any one of claims 1 to 5 or a compound according to any one of claims 6 to 8 in the manufacture of a medicament for use in the prevention or treatment of HCV infection.
- 5 11. A process for the preparation of a composition according to any one of claims 1 to 5, which process comprises mixing the constituents thereof in the required proportions.
- 10 12. A process for the preparation of a compound according to any one of claims 6 to 8, which process comprises expressing DNA encoding said compound in a recombinant host cell and recovering the product.
- 15 13. A DNA molecule encoding a compound according to any one of claims 6 to 8.
14. A recombinant vector comprising the DNA of claim 13.
15. A host cell transformed with the recombinant vector of claim 14.